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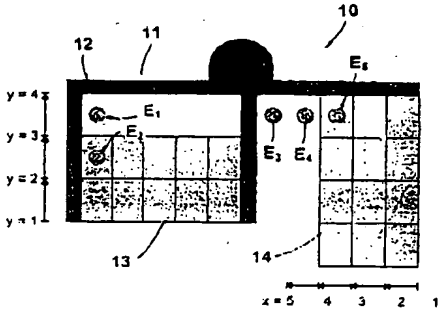
(54) Title: Apparatus for optoelectronic detection of switching positions of a switching means



(57) Abstract: The invention relates to a device for the optoelectronic detection of switching positions of a mechanically actuatable, positively driven switching element. The inventive device comprises individual photoelectric receivers (5, 6; E1 - E5), at least one light source (3) which is arranged in such a way that it exposes the receivers (5, 6; E1 - E5), and a shutter (2, 11). The arrangement consisting of the light source (3) and receivers (5, 6; E1 - E5) can be moved in relation to the shutter (2, 11) and the mobile element is coupled to the movement of the switching element. The inventive device is characterised in that at least two receivers (5, 6; E1, E2; E3 - E5) are respectively arranged at a distance from each other corresponding to at least one switching step, in the switching direction of the switching element, and the shutter (2, 11) comprises a shading region (13, 14) by which means only the state of an individual receiver (5, 6; E1 - E5) changes when the switching position changes to an adjacent switching position of the switching element.

Apparatus for optoelectronic detection of switching positions of a switching means

The invention concerns an apparatus for optoelectronic detection of switching positions of a mechanically actuatable, constrained switching means, and concerns in particular such an apparatus including individual photoelectric receivers, at least one light source arranged so as to expose the receivers and a shutter, the arrangement consisting of the light source and receivers being movable relative to the shutter and the movable element being coupled to the movement of the switching means.

Apparatuses for detecting switching positions are used, say, in switches which are assigned multiple functions in order to allow a user to recognize which switching or switch position a multifunction switch of this sort is currently in. Switches of this sort are used, say, as lighting or steering column switches in motor vehicles. To allow the plurality of functions to be executed independently of one another and in parallel to one another, switches of this sort are configured to be movable in multiple planes. In order to represent the respective switching position, backlit symbols can be assigned to the switch, as a function of the respective switch position the symbol(s) being backlit which stand for the functions which are actually switched on.

Switches of this sort are conventionally configured as contact switches so that a switch position is attained if the corresponding electrical connection is produced by the switching organ. Even if a plurality of different functions can be switched with a multifunctional switch of this sort, the cost increases inordinately in case of complicated switch structures if the respective switch positions are to be detected in the above described manner. Moreover, the elements provided for mechanical contact-making are subject to the effects of wear and aging.

Here, switching position detection can be used not only to show this to a user, but also the respective switching position should also be made accessible as a data input to a data processing system such as an onboard computer in motor vehicles for monitor and control purposes.

Multifunctional switches can be configured as contactless optoelectronic-functioning switches, as is known from DE 43 32 748 A1. The switch described in this document is characterized in that no electrical contact-making needs to be brought about in order to detect a switching position; instead, a photosensitive element as a receiver is exposed to

light if the switching means is in a certain switching position. An optical switch of this sort includes, besides the photosensitive element, a light source which can be arranged, say, on the same board as the photosensitive element. By means of a fiber-optical member whose area on the light output side is arranged facing the photosensitive surface of the photoelectric element, the required light is brought to the photoelectric element. Between the output side of the fiber-optical member and the photoelectric element, a movement gap is provided in which a shutter coupled to the movement of the switching means is movable. The shutter has an opening at a specified position so that after a movement of the switching means to a certain switching position, the opening is in alignment with the area on the output side of the fiber-optical member and the photosensitive surface of the photoelectric element so that the latter can be exposed to light. If the switching means is removed from this position, the photoelectric element is shaded and the switching position exited. In the subject matter of this document, each switching position is thus realized through its own optoelectronic switch. Through suitable arrangement of several such optical switches, even complicated switching operations can be detected. However, under conditions where installation space is limited, it is not possible to realize complicated switching operations in the described manner.

In DE 298 17 668 U1, a further switching position detection apparatus has been disclosed which is configured to function in an optoelectronic manner. In the subject matter of this document, a light source is coupled to the movement of the switching means and is thus tracked along with any movement it makes. The light source acts upon a two-dimensional sensor array, formed from a plurality of individual converter elements, e.g., a camera sensor. Switching position detection occurs as a function of which converter elements of the sensor array are exposed to light as a function of the position of the switching means. However, this known switching position detection device requires a microprocessor for its evaluation and is thus more expensive than the previously described one.

Starting out from this discussed prior art, the underlying object of the invention is to further develop a generic switching position detection apparatus named in the introduction such that it can be implemented using simple means while avoiding the disadvantages which were pointed out in the known prior art.

This objective is solved according to the invention in that at least two receivers are arranged in each case at a distance correspondingly from each other of at least one switching step in the switching direction of the switching means and that the shutter has a

shading region through which in each case only the state of a single receiver changes when the switching position changes to an adjacent switching position of the switching means.

Moreover, this invention [is characterized] by an apparatus for optoelectronic detection of switching positions of a mechanically actuatable, positively driven switching means, including a photoelectric receiver, at least a plurality of light sources arranged so as to expose the receiver and a shutter, the arrangement consisting of the light sources and receiver being movable relative to the shutter and the movable element being coupled to the movement of the switching means, at least two light sources being arranged in each case at a distance correspondingly from each other of at least one switching step in the switching direction of the switching means and the shutter having a shading region through which in each case only a single light source changes its state in terms of an exposure of the receiver when the switching position changes to an adjacent switching position of the switching means.

In the switching position detection apparatus according to the invention corresponding to the first proposed solution, unlike the known prior art, it is provided to use a receiver arrangement formed from at least two receivers as well as a shutter having a shading region which is configured so that for a change in the switching positions in each case only one receiver changes its state. For example, the shading region can be designed so that all of the receivers are simultaneously shaded. In a configuration of this sort, when using two receivers, basically four switching steps can be detected. At least two receivers are arranged in each case at a distance correspondingly from each other of at least one switching step in the switching direction of the switching means. Since the shutter has a shading region with which possibly both receivers can be simultaneously shaded, a switching position being defined in this manner, it is also possible to shade only the one receiver as well as also the other receiver or even no receivers, the three further switching positions in a configuration of this sort being defined in this manner. If four switching steps are provided, if a partial shading of individual receivers is not provided, only two receivers are required so that the number of receivers used is reduced by 50% compared to the receiver count required in the known prior art. If partial shading is provided, the number of required receivers can be further reduced compared to the known prior art. To avoid erroneous interpretations, it is provided moreover in the subject matter of the claimed switching position detection apparatus that for a change in the switching position to an adjacent switching position of the switching means, in each case only a single

receiver changes its state. This state change can be caused through exposure of a previously unexposed receiver or vice versa, or also by changing the exposure intensity, e.g., through regional shading of a receiver by the shutter.

Corresponding to the second proposed solution, the switching position detection apparatus is similarly configured. Compared to the previously described switching position detection apparatus, the roles of the light source and receiver are swapped. In this second proposed solution, at least two light sources are provided and in contrast only a single receiver. The light emitted by the light sources is encoded, e.g., pulsed over time. Based on a corresponding evaluation of the received signal, a switching position can be detected. A light encoding can take place, say, also via the wavelength, different light sources emitting light with a different wavelength.

With no further ado, the switching position detection apparatus according to the invention is also suitable for carrying out a switching position detection if the switching means is movable in two or more directions. In each direction of movement of the switching means, a receiver arrangement consisting of at least two receivers and the shutter with its shading region is conceived (both as described above). Due to the decrease in hardware compared with the known prior art, even complicated switching operations can be detected in an optoelectronic manner with a switching position detection apparatus of this sort without the need for a larger installation space.

In order to utilize this switching position detection apparatus, the use of a microprocessor is not necessary as a basic rule. The evaluation can take place via a digital circuit via which the output signal is fed directly to a device which further processes the output signal of the switching position detection apparatus. For example, a digital circuit of this sort can be a binary decoder.

The use of an IR light source is advisable for operating a switching position detection device of this sort. In a configuration of this sort, in each case a filter which passes IR light is connected upstream of the receivers used so that the switching position detection apparatus does not need to be encapsulated with respect to otherwise disruptive daylight.

For the case in which a microprocessor is available in the surroundings of the switching position detection apparatus, such as in a motor vehicle, instead of the discrete photoelectric receivers used, a sensor array constructed from a plurality of individual

photoelectric receivers, e.g., a row or camera sensor can also be employed.

The invention is described hereafter based on exemplary embodiments with reference to the attached figures. The figures are as follows:

Fig. 1a-d: A schematic representation of an switching position detection device which functions in an optoelectronic manner with which four switching positions can be implemented in a switching direction, and

Fig. 2: A schematic representation of a further switching position detection device whose switching means is movable in two directions

Fig. 1a shows a schematic representation of a switching position detection apparatus 1 on whose switching means (not shown) a shutter 2 is arranged. The shutter 2 forms a shading region in its full width shown in Fig. 1a. The shutter 2 is coupled to the movement of the switching means and is displaceable in the plane indicated by the double arrow. The representation of the movement of the shutter 2 in a plane is used to simplify the representation. Actually, the switching means is coupled so as to be swivelable about a rotational axis so that the shutter 2 is also moved on an orbit. On the one side of the shutter, a light source 3 is arranged in a stationary manner with respect to it which light source 3 is an LED which emits IR light in the shown exemplary embodiment. On the other side of the shutter 2, a receiver arrangement 4 is also formed in a stationary manner with respect to the shutter 2 which receiver arrangement 4 consists of two discrete photoelectric receivers 5, 6. The light source 3 and the receivers 5, 6 are arranged in an expedient manner on a common board. The two receivers 5, 6 are IR-sensitive. In order to suppress daylight reflections, a filter which passes only IR light is connected upstream of the receivers 5, 6. The receivers 5, 6 are connected to an evaluation circuit designated with the reference number 7.

With the switching position detection apparatus 1, four switching positions can be implemented of which a first one is shown in Fig. 1a. In this switching position, both receivers 5, 6 are exposed by the light source 3. The second switching position of the switching means is shown in Fig. 1b. In this switching position, the receiver 6 is shaded by the front part 8 of the shutter 2 so that this switching position is characterized by an output signal indicating a sole exposure of the receiver 5. Fig. 1c shows a third switching position of the switching position detection apparatus 1 in which both receivers 5, 6 are

shaded with respect to the light emitted by the light source 3. In this position, the front region 8 of the shutter 2 shades the receiver 5 and the rear region 9 of the shutter 2 shades the receiver 6. The fourth switching position is shown in Fig. 1d in which the rear region 9 of the shutter 2 shades the receiver 5 so that the output signal of the switching position detection apparatus reflects only an exposure of the receiver 6.

In the switching sequence as shown, it is recognizable that a position change leads only to the change of the state of a single receiver 5 or 6. In this manner, erroneous interpretations are prevented which could arise if two receivers were to change their state after one another and not simultaneously.

Fig. 2 shows a schematized representation of a further switching position detection apparatus 10 which, unlike the switching position detection apparatus 1 in Figs. 1a – 1d, enables switching position detection in two directions. The switching means of the switching position detection apparatus 10 is supported so as to be swivelable about two rotational axes. A shutter 11 is coupled to the movement of the switching means, the shutter 11 being built in the shown exemplary embodiment from a holder 12 which supports two shading strips 13, 14. Each shading region 13, 14 is used for switching position detection of a receiver arrangement in each case. A receiver arrangement built from the receivers E_1 and E_2 is used for switching position detection of a movement of the switching means in the y direction. The further receiver arrangement, built from the receivers E_3 - E_5, is used for detecting a switching position of the switching means in the x direction. The receivers E_1, E_2 or rather E_3 - E_5 are arranged at a distance correspondingly from each other of one switching step in each case. The shading strips 13, 14 are sectioned into boxes in order to illustrate the different switching positions of the switching means. In the y direction, four switching positions can be detected through the use of two receivers E_1, E_2. In the x direction, five switching positions can be detected in this embodiment through the use of three receivers E_3 - E_5. The states of the individual receivers E_1 - E_5 in the different switching positions of the switching position detection apparatus 10 are given in the following table:

y position	E_1	E_2
1	light	dark
2	dark	dark
3	dark	light
4	light	light

x position	E_3	E_4	E_5
1	light	light	dark
2	light	dark	dark
3	dark	dark	dark
4	dark	dark	light
5	dark	light	light

In order to detect six x switch positions, the described arrangement can be modified such that the shading strip 13 is six boxes wide. The "x = six" position can be determined in that the receivers E_3 - E_5 are exposed.

In order to simplify the representation of the shutter 11, it is represented laid out in a plane in Fig. 2. Actually, it is curved, the midpoint of the curve being located at the intersection of the two rotational axes of the switching means. In the immediate vicinity of the intersection of the rotational axes of the switching means, the light source (not shown in Fig. 2) is also arranged.

From the description of the invention, it is clear that with the described switching position detection apparatuses a plurality of switching positions, e.g., of a steering column switch of a motor vehicle, can be detected even in a very small installation space and with only a minimum of hardware. Instead of the arrangement shown in the figures in which the shutters are movable and the receivers and the light source are arranged in a stationary manner, it can also be provided to arrange the shutter in a stationary manner and the other elements movable. Basically, it is also possible instead of the used discrete receivers to use a sensor array, e.g., a camera sensor, on which discrete regions of a switching position are assigned.

The term shading or rather shading region used in these documents includes on the one hand an arrangement as is described in the figures so that a direct shading takes place through a shading region of this sort. However, this term can also be understood to mean a configuration in which mirrors are also used as the shutter so that the light source and receiver are arranged on the same side of the shutter and an exposure of a receiver takes place in a corresponding mirror position.

List of reference numbers

1	Switching position detection apparatus
2	Shutter
3	Light source
4	Receiver arrangement
5	Receiver
6	Receiver
7	Evaluation circuit
8	Front region of shutter
9	Rear region of shutter
10	Switching position detection apparatus
11	Shutter
12	Holder
13	Shading strip
14	Shading strip
E_1 - E_5	Receivers

Claims

1. An apparatus for optoelectronic detection of switching positions of a mechanically actuatable, positively driven switching means, including individual photoelectric receivers (5, 6; $E_1 - E_5$), at least one light source (3) arranged so as to expose the receivers (5, 6; $E_1 - E_5$) and a shutter (2, 11), the arrangement consisting of light source (3) and receivers (5, 6; $E_1 - E_5$) being movable relative to the shutter (2, 11) and the movable element being coupled to the movement of the switching means, **characterized in that** at least two receivers (5, 6; E_1, E_2; $E_3 - E_5$) are arranged in each case at a distance correspondingly from each other of at least one switching step in the switching direction of the switching means and that the shutter (2, 11) has a shading region (13, 14) through which in each case only the state of a single receiver (5, 6; $E_1 - E_5$) changes when the switching position changes to an adjacent switching position of the switching means.

2. An apparatus for optoelectronic detection of switching positions of a mechanically actuatable, positively driven switching means, including a photoelectric receiver, at least several light sources arranged so as to expose the receiver and a shutter, the arrangement consisting of light sources and receiver being movable relative to the shutter and the movable element being coupled to the movement of the switching means, wherein at least two light sources are arranged in each case at a distance correspondingly from each other of at least one switching step in the switching direction of the switching means, and the shutter has a shading region through which in each case only a single light source changes its state in terms of an exposure of the receiver when the switching position changes to an adjacent switching position of the switching means.

3. The switching position detection apparatus according to claim 1 or 2, **characterized in that** the switching means is movable in two or more directions and has in these directions in each case a receiver arrangement or rather light source arrangement provided for realizing the switching positions and the shading region (13, 14) of the shutter (2, 11) is conceived correspondingly.

4. The switching position detection apparatus according to one of the claims 1 to 3, **characterized in that** the switching means is supported in a rotatable manner about one or more axes, the light source or rather the receiver is located in the region of the

intersection of the rotational axes, and the shutter (11) has a curved surface at least in the shading region with its curve midpoint at the intersection of the rotational axes.

5. The switching position detection apparatus according to one of the claims 1 to 4, **characterized in that** light sources which emit IR light are used as light source (3) or as light sources and the receiver(s) are IR-sensitive and include a filter which passes IR light.

6. The switching position detection apparatus according to one of the claims 1 or 3 to 5, **characterized in that** a binary decoding circuit for direct generation of a digital output signal is allocated to each receiver arrangement (4).

7. The switching position detection apparatus according to one of the claims 1 or 3 to 5, **characterized in that** a sensor array constructed from a plurality of individual photoelectric receivers, e.g., a camera sensor, is used as receiver.